Surgical procedures of the elbow: a nationwide cross-sectional observational study in the United States

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Abstract: BACKGROUND: Elbow surgery is shared by several subspecialties. We were curious about the most common elbow surgeries and their corresponding diagnoses in the United States. METHODS: We used the National Hospital Discharge Survey (NHDS) and the National Survey of Ambulatory Surgery (NSAS) data gathered in 2006-databases that together provide an estimate of all inpatient and ambulatory surgical care in the US. RESULTS: An estimated 150,000 elbow surgeries were performed in the US in 2006, 75% in an outpatient setting. The most frequent diagnosis treated operative was enthesopathy (e.g. lateral epicondylitis) and it was treated with several different procedures. More than three quarters of all elbow surgeries treated enthesopathy, cubital tunnel syndrome, or fracture (radial head in particular). Arthroscopy and arthroplasty accounted for less than 10% of all elbow surgeries. CONCLUSIONS: Elbow surgery in the United States primarily addresses enthesopathies such as tennis elbow, cubital tunnel syndrome, and trauma. It is notable that some of the most common elbow surgeries (those that address enthesopathy and radial head fracture) are some of the most variably utilized and debated.

RESEARCH ARTICLE

Surgical Procedures of the Elbow: A Nationwide Cross-Sectional Observational Study in the United States

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Key words: Ambulatory care, Elbow diagnosis, Elbow surgery, Inpatient care, National surveys

Introduction

When one thinks of shoulder surgery, labral and rotator cuff repairs and total joint arthroplasty come to mind. For hand surgery, carpal tunnel release and trigger finger. But what about elbow surgery? It's not quite as clear what comprises elbow surgery.

Surgery of the elbow is shared by many subspecialties of orthopaedic surgery. Both "shoulder and elbow" and "hand and upper extremity" surgeons claim the elbow (1). Sports surgeons take care of elbow problems in throwing athletes and many are expert at elbow arthroscopy (2, 3). Trauma and its sequellae account for a substantial percentage of elbow surgery, bringing in the orthopaedic traumatologists (4). Traditionally, the arthroplasty surgeon did total elbow arthroplasty (5, 6). Oncological orthopaedic surgeons and pediatric orthopaedic surgeons also operate on the elbow (7). With increasing attention placed on training, experience, and so-called "centers of excellence", it would be helpful to understand which diagnoses and procedures comprise elbow surgery. Such knowledge could inform training, education, organization, and policy with the potential to improve the quality and effectiveness of elbow surgery (8, 9).

This study used inpatient and outpatient databases that together provide an estimate of all inpatient and ambulatory elbow surgeries performed in a single year (2006) in the United States to identify the most common diagnoses and procedures in elbow surgery.

Material and methods

The Centers for Disease Control and Prevention (CDC, Atlanta, GA) provided us with the National Hospital Discharge Survey (NHDS) and the National Survey of Ambulatory Surgery (NSAS) data gathered in 2006, which was the most recent year that both types of data were collected. The NHDS and NSAS collect data from

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Table 1. Demographics of Patients that had elbow surgery in 2006

Parameter		Inpatient Surgery		Outpatient Surgery		Total	
		n	%	n	%	n	%
Number of elbow surgeries		37665	25	110899	75	148564	
Sex	Men	18840	50	52690	48	71530	48
	Women	18825	50	58209	52	77034	52
Discharge status	Routine, discharged to home	29467	78	97672	88	127139	86
	Non-routine discharge	6723	18	4597	4	11320	8
	Status not stated	1475	4	8630	8	10105	7
Source of payment	Medicare	11094	29	21703	20	32797	22
	Medicaid	4474	12	3027	3	7501	5
	Worker's company	2435	6	12561	11	14996	10
	Private or commercial insurance	15285	41	69756	63	85041	57
	Self-pay	3380	9	210	0	3590	2
	Other government	376	1	2680	2	3056	2
	No charge	0	0	409	0.4	409	0.3
	Other	621	2	462	0.4	1083	0.7
Month of surgery	December - February	7407	20	31535	28	38942	26
	March - May	7750	21	18668	17	26418	18
	June - August	10704	28	32851	30	43555	29
	September - November	10427	28	27845	25	38272	26
	Unknown	1377	4	0	0	1377	1
		Mean (±SD)	Range	Mean (±SD)	Range	Mean (±SD)	Range
Age		51 (±20)	18-97	50 (±16)	18-90	50 (±17)	18-97

a nationwide subset of healthcare facilities selected to represent the geographic, socioeconomic, and organization variations in the United States. Using a weighing system (multipliers for the relative number of specific hospital types), these data represent an estimate of all patients treated in the United States. The IRB of our institution declared this study exempt from oversight because there was no identifiable health information.

The NHDS contains medical and demographical information of inpatient care collected from a nationally representative sample of 500 hospitals. Federal, military, and Department of Veterans Affairs hospitals, as well as hospital units of institutions (such as prison hospitals), and hospitals with fewer than six beds staffed for patient use, are excluded. The NHDS contains weighted data representing almost 32 million admissions (10).

The NSAS is a publicly available database that contains medical and demographical information of ambulatory surgical care collected from a nationally representative sample of hospital-based or freestanding ambulatory surgery centers. The NSAS contains weighted data representing almost 35 million outpatient surgeries (11).

The two datasets combined provided us with an estimate of all elbow surgeries performed in the United States in 2006. The patient characteristics available were diagnoses, procedures, type of admission, sex, age, discharge status, source of payment, and month of surgery/visit [Table 1]. Diagnoses and procedures were coded using the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). Using these codes, we identified all surgical procedures involving the elbow and their corresponding diagnoses. Procedures with a code that was not elbow-specific (e.g. arthropathy, unspecified, upper arm [716.92] and open reduction internal fixation, radius and ulna [79.32]) were included only when they had a corresponding elbow diagnosis. Many patients had more than one elbow diagnosis or procedure.

We also included nonspecific procedure codes if they were highly likely to involve the elbow (e.g., other peripheral nerve decompression [04.49] associated with ulnar nerve lesion [354.2]) [Tables 2; 3].

Results

An estimated 110,899 outpatient (75%) and 37,665 inpatient (25%) elbow surgeries were performed in the United States in 2006, for a total of 148,564 surgeries or 50 per 100,000 US population in 2006. Ambulatory patients were more likely to use private or commercial insurance and less likely to use Medicare [Table 1].

The most common diagnoses were elbow enthesopathy, cubital tunnel syndrome, and fracture of the radial head or olecranon. The vast majority of inpatient elbow surgery addressed fractures. Ambulatory surgery

Table 2. Most Common Diagnoses Associated with Elbow Surgery

Diagnosis	IDC-9-CM	Number of Patients	% of All Elbow Diagnoses	Inpatient Surgeries	% Inpatient Elbow Diagnoses	Outpatient Surgeries	% Outpatient Elbow Diagnoses
Elbow enthesopathy or bursitis	726.30 - 726.39	49020	31	2365	5.7	46655	41
Cubital tunnel syndrome	354.2	38609	24	755	1.8	37854	33
Closed fracture of the proximal radius and/or ulna	813.00 - 813.08	28441	18	17145	41	11296	9.9
Closed fracture of the distal humerus	812.40 - 812.49	10557	6.6	8089	20	2468	2.2
Sprains or strain	841.9	5211	3.3	485	1.2	4726	4.1
Open wound of elbow	881.01	5041	3.2	5041	12	0	0.0
Osteoarthrosis	715.92	4457	2.8	0	0.0	4457	3.9
Other joint derangement	718.82	2598	1.6	0	0.0	2598	2.3
Open fracture of the proximal radius and/or ulna	813.10 - 813.18	2387	1.5	2152	5.2	235	0.2
Open fracture of the distal humerus	812.50 - 812.59	2222	1.4	2222	5.4	0	0.0
Synovitis	727.00	2281	1.4	0	0.0	2281	1.9
Contracture	718.42	1792	1.1	1526	3.7	266	0.2
Rheumatoid arthritis	714.0	1610	1.0	388	0.9	1222	1.1
Elbow dislocation	832.00 - 832.19	1480	0.9	1294	3.1	186	0.2
Total		155706		41462		114244	

addressed enthesopathy, cubital tunnel syndrome, and fracture in descending order of frequency [Table 2].

The most common specific elbow surgery was ulnar nerve decompression, followed by open reduction and internal fixation of the proximal radius and/or ulna, and other partial ostectomy of the humerus. Partial ostectomy (e.g. medial epicondylectomy) was done for enthesopathy in 70% of patients and for lesions of the ulnar nerve in 30%. Total elbow arthroplasty and elbow arthroscopy represent a relatively small proportion of all elbow surgeries (both less than 4% of the total) [Table 3].

Discussion

Surgery of the elbow is shared by several orthopaedic subspecialties. Elbow surgery seems relatively uncommon and we were not sure about the most common elbow procedures performed in the United States. The availability of two datasets that together provide estimates for all inpatient and outpatients surgeries performed in the United States in 2006 provided an opportunity to study the most common types of elbow surgeries.

There are several important limitations to keep in mind when interpreting these data. First, the study is based on an estimated number of patients resulting from a nationwide sample. Second, because of the large scale of data collection, data are only available to researchers several years after the referenced year and things may have changed since 2006. These large databases may be susceptible to administrative misclassification and coding errors; however, quality control programs have estimated the error rate as less than half a percent (12). Third, not all ICD-9-CM codes are specifically for the elbow. For example, nonunion of a fracture (733.82) can occur in any part of a bone of the body or open reduction with internal fixation of the humerus (79.31) might be a procedure of the proximal as well as distal part of the humerus. We addressed this issue by matching procedures with elbow specific diagnoses and we believe that very few procedures were missed. Finally, the databases did not provide information about surgeon volume and surgeon subspecialty.

It is notable that the top indication for an elbow surgery is enthesopathy (e.g. so-called "tennis elbow")—a condition for which surgery is discretionary, the role of operative treatment is debated, and the rate of surgery varies substantially from surgeon to surgeon. Elbow enthesopathies are common between 35 and 60 years of age, and they are largely benign and self-limited (13, 14). It is possible that shared decision making tools might decrease the rate of surgery for enthesopathy substantially, thereby notably reducing the field of elbow surgery.

Fracture treatment is the second most common indication for elbow surgery in the United States, proximal radius and ulna fractures in particular. With ICD-9 codes, it's not possible to determine which type of fracture is being treated. The most common elbow fracture by far is fracture of the radial head. Most radial head fractures are not associated with other fractures or ligament injuries. The role of surgery for stable, partial articular fractures with slight displacement is debated (15, 16). If data documenting excellent long-term results of nonoperative treatment is corroborated with additional study, and this data is effectively communicated to patients using tools for shared decision-making the rate of surgery for radial head fractures may decline. The most common proximal ulna fracture is a simple fracture of the olecranon. Most of these are displaced and merit surgery, with little debate between surgeons about indications, although nonoperative treatment is growing in popularity among older, more infirm patients (17-20). Fractures of the distal humerus and traumatic elbow instability are

Table 3. Procedures of the elbow

Procedures	ICD-9-CM	Number of patients	Percentage (%)
Ulnar nerve transposition	04.49	38609	23.0
Open reduction and internal fixation, radius and ulna	79.32	25207	15.0
Other partial ostectomy; humerus	77.82	15009	8.9
Bursectomy	83.5	12847	7.6
Division of joint capsule, ligament, or cartilage, elbow	80.42	12448	7.4
Open reduction and internal fixation, humerus	79.31	9291	5.5
Arthroplasty; Other repair of elbow	81.85	6390	3.8
Other local excision or destruction of lesion of joint, elbow	80.82	6257	3.7
Arthroscopy elbow	80.22	5551	3.3
Other excision of joint, elbow	80.92	4549	2.7
Other arthrotomy, elbow	80.12	3942	2.3
Synovectomy of elbow	80.72	2717	1.6
Arthrodesis of elbow	81.24	2444	1.5
Other partial ostectomy; radius and ulna	77.83	2388	1.4
Arthroplasty; Total elbow replacement	81.84	2232	1.3
Debridement of open fracture site; radius and ulna	79.62	2176	1.3
Debridement of open fracture site; humerus	79.61	1671	1.0
Removal of implanted devices from bone, humerus	78.62	1609	1.0
Other incision of bone without division, humerus	77.12	1530	0.9
Local excision of lesion or tissue of bone; humerus	77.62	1237	0.7
Closed reduction without internal fixation, humerus	79.01	1221	0.7
Closed reduction and internal fixation, humerus	79.11	1142	0.7
Closed reduction of dislocation of elbow	79.72	1041	0.6
Closed reduction without internal fixation, radius and ulna	79.02	811	0.5
Arthrotomy for removal of prosthesis without replacement, elbow	80.02	734	0.4
Application of external fixator device; humerus	78.12	715	0.4
Application of external fixator device; radius and ulna	78.13	715	0.4
Removal of implanted devices from bone, radius	78.63	657	0.4
Closed reduction and internal fixation, radius	79.12	620	0.4
Local excision of lesion or tissue of bone; radius and ulna	77.63	408	0.2
Limb shortening procedures; radius and ulna	78.23	311	0.2
Other repair or plastic operations on bone; humerus	78.42	296	0.2
Bone grafting nonunion/delayed union, humerus	78.02	272	0.2
Closed reduction of separated epiphysis; humerus	79.41	266	0.2
Other division of bone, radius and ulna	77.33	183	0.1
Other division of bone, humerus	77.32	127	0.1
Open reduction of separated epiphysis; radius and ulna	79.52	112	0.1
Internal fixation of bone without fracture reduction; radius and ulna	78.53	109	0.1
Open reduction of dislocation of elbow	79.82	103	0.1
Other repair or plastic operations on bone; radius and ulna	78.43	67	0.0
Bone grafting nonunion/delayed union, radius and ulna	78.03	60	0.0
Amputation humerus	84.07	42	0.0
Closed reduction of separated epiphysis; radius and ulna	79.42	34	0.0
Open reduction without internal fixation, radius and ulna	79.22	27	0.0
Internal fixation of bone without fracture reduction; humerus	78.52	26	0.0
Open reduction without internal fixation, humerus	79.21	20	0.0
Total procedures of the elbow, humerus, radius, and ulna		168223	

relatively uncommon. A reduction in the rate of surgery for isolated slightly displaced partial articular fractures of the radial head could also result in a notable reduction in elbow surgery in general.

Cubital tunnel syndrome is the second most common peripheral mononeuropathy after carpal tunnel syndrome (21). In analogy with carpal tunnel syndrome, it is possible that this structural disease (tight cubital tunnel) is largely genetically mediated (good evidence for carpal tunnel, but not yet for cubital tunnel syndrome) (22). While there is substantial variation in diagnostic testing, diagnosis, and timing of a recommendation for surgery, surgery for cubital tunnel syndrome is probably necessary to prevent atrophy of the intrinsic muscles of the hand and is therefore less discretionary (21, 23). If the treatment of cubital tunnel syndrome becomes less about the relief of symptoms and more about prevention of permanent neuropathology (weakness, atrophy, and numbness), it is possible that the rate of cubital tunnel release operations might increase. That depends, in part, on the percentage of surgeries on the ulnar nerve for questionable indications such as pain in the absence of objective evidence of nerve pathology—a subset of surgeries that might reduce with better evidence and shared decision-making.

Based on data from 2006, elbow surgery comprises approximately 150,000 surgical procedures a year in the United States, 75% ambulatory. Elbow surgery primarily addresses enthesopathy, cubital tunnel syndrome, and trauma and is most common in middle-aged people. It is notable that some of the most common procedures (enthesopathy procedures, radial head fracture procedures) are some of the most variably utilized and debated. It is also notable that the top elbow surgeries are straightforward surgeries that most non-specialists are comfortable performing. These data help define elbow surgery; suggest how elbow surgery may change and even decrease as evidence accumulates and is disseminated and as tools for shared decision-making are more routinely implemented; and inform efforts to educate, train, and organized experts in elbow surgery.

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